REMARKS

Claims 1-17 and 23-25 are pending in the application. Claim 23 has been cancelled by this amendment. Therefore, claims 1-17, 24, and 25 are at issue.

This amendment is submitted in accordance with 37 C.F.R. §1.116(a) and §1.116(b) in order to present the rejected claims in a better form for allowance or appeal. The amendment is necessary to eliminate rejections under 35 U.S.C. §103. This amendment was not presented earlier because the rejection under 35 U.S.C. §103 is a new ground of rejection. The amendment should be entered because it places the application in better form for allowance or appeal, and the amendment does not require further searching or present any new issues.

The courteous interview granted by Examiner Taylor to applicants' undersigned attorney on June 23, 2009 is hereby acknowledged with appreciation. During the interview, the pending claims, outstanding Office Action, cited references, and proposed claim amendments were discussed.

In this amendment, claim 1 has been amended to incorporate the features of claim 23 and recite that the hydrogel-forming polymer particles comprise a partially neutralized polyacrylic acid.

In a previous action, the examiner indicated that a certified copy of the priority documents was not received. As previously noted, the present application is a §371 application of PCT Application No. PCT/EP05/003009, and the priority document was filed during the international phase of the application. See Notice of Acceptance of Application under 35 U.S.C. §371 mailed on July 13, 2007, clearly stating that the priority documents have been received. In view of the above, it is requested that the examiner acknowledges foreign priority in the next communication in connection with the above-identified application.

Claims 1, 3-9, 12, 13, 16, 17, and 23-25 stand rejected under 35 U.S.C. §103 as being obvious over Goldman et al. U.S. Patent No. 5,562,646 ('646) in view of Allen U.S.

Patent No. 5,786,429 ('429), as evidenced by Dvornic et al. U.S. Patent No. 5,739,218 ('218), in view of Kobayashi U.S. Patent No. 5,489,469 ('469). Applicants traverse this rejection.

Claim 1 has been amended to recite swellable hydrogel-forming polymer particles comprising partially neturalized polyacrylic acid having at least one hydrophilic polymer of dendritic structure (dendritic polymer) and at least one water-insoluble phosphate present on the surfaces of the particles.

Example 5 also provides an excellent description of the invention recited in independent claim 1 and the dependent claims. In particular, the example discloses the preparation of superabsorbent (SAP) particles from a monomer solution containing partially neutralized acrylic acid (specification, page 19, line 41 through page 20, line 6). The SAP particles are dried, then sized to a desired particle size range by sieving (specification, page 20, lines 8 and 9). The SAP particles then are postcrosslinked, wherein the postcrosslinking solution contains a dendritic polymer (BOLTORN H40) and tricalcium phosphate (specification, page 20, lines 29-36). The postcrosslinking solution is sprayed onto the SAP particles to position the dendritic polymer and water-insoluble phosphate on the surfaces of the SAP particles (specification, page 20, lines 40-41). The dendritic polymer and water-insoluble phosphate also can be applied to the SAP particle surfaces in the same manner in the absence of a surface postcrosslinker (specification, page 5, lines 30-35, for example).

Postcrosslinked SAP particles are illustrated in the previously provided Exhibit A, i.e., page 97 from *Modern Superabsorbent Polymer Technology*, T. Buchholz et al. eds. (1998). Fig 3.9 of page 97 illustrates the positioning of the dendritic polymer and water-insoluble phosphate on the surfaces of the SAP particles, with or without surface postcrosslinking.

The swellable hydrogel-forming polymer particles of the present claims therefore comprise (a) an SAP particle comprising partially neutralized polyacrylic acid, (b) a dendritic polymer, and (c) a water insoluble phosphate, wherein both (b) and (c) are present on the surfaces of the SAP particles.

The '646 patent discloses an absorbent core containing a hydrogel forming absorbent polymer, i.e., an SAP. The absorbent core can further contain fibrous materials, such as cotton, kemp, flax, synthetic fibers, etc., as set forth at columns 23-26 of the '646 patent. The '646 patent fails to teach or suggest *any* dendritic polymers.

The primary '646 patent is relied upon for disclosing SAP particles, and the secondary '429 patent is relied upon for disclosing a polymer of dendritic structure. However, as discussed at the interview, the '429 patent does not disclose a polymer of dendritic structure, but merely an intralinked polyamidoamine prepared in a single step process by reacting a polyamidoamine and a crosslinking agent to provide the polymeric structure of Fig. 1 of the '429 patent. The polymer in that figure is not a polymer of dendritic structure.

The '218 patent cited by the examiner is directed to dendritic polymers, and such radially layered polymers have a substantially different structure than the polymer of the '429 patent. The '218 patent cited the publication, D.A. Tomalia, *Scientific American, 272* page 62-66 (1995), submitted concurrently with this amendment as Exhibit B, which illustrates the radial structure of a dendritic polymer resulting from the stepwise reactions used to prepare a dendritic polymer. The stepwise preparation of a dendritic polymer also is discussed in the present specification at page 4, lines 10-13. Applicants further provide a technical brochure for BOLTORN® dendrite polymers as Exhibit C, which provides another illustration of a dendritic polymer.

It should further be noted that the '218 patent discloses differences between dendritic polymers and other polymers at column 1, lines 44-46. In short, the term "polyamidoamine" defines the types of bonding in the polymer, but not the structure of the polymer. Thus, the recitation of a polyamidoamine (e.g., claim 3) is not rendered obvious by the '646 and '429 patents because the '429 patent does not disclose a dendritic polymer.

In addition, the '429 patent was cited because the polymers disclosed therein are wet and dry strength agents and adhesives for cellulosic and fibrous webs. However, the present claims are directed to hydrogel forming polymeric *particles*, and accordingly the benefits of wet strength, dry strength, and adhesion are not relevant. Such properties relate to

papers, foams, and the like, but not particles. Further, adhesion between particles is a property to be avoided, not sought after. Persons skilled in the art therefore have no apparent reason to combine the teachings of the '429 patent and the '646 patent.

The tertiary '469 patent is directed to SAP particles having a fibrous material and an inorganic material on the surface of the particle. The '469 patent fails to teach or suggest any dendritic polymer. The Office Action states that the '469 patent teaches phosphates as improving the capacity, rate, and power of absorbing liquids. However, the '469 patent at column 1, lines 55-59 states that these are *desired* in a water-absorbent polymer, i.e., is the problem to be solved. The '469 patent attempts to solve this problem by applying a water-insoluble inorganic material *and* a fibrous material to a water-absorbent polymer particle (see '469 patent, column 2, lines 9-13). The '469 patent further teaches that the absence of any of these constituents has an adverse effect ('469 patent, column 3, lines 33-37). Persons skilled in the art therefore would have had no incentive to apply a water-insoluble inorganic to a particle surface, while omitting the fibrous material, with any reasonable expectation of providing a useful hydrogel-forming polymer particle.

For the reasons set forth above, and as discussed in the interview, it is submitted that the cited combination of references fails to render claims 1, 3-9, 12, 13, 16, 17, and 23-25 obvious under 35 U.S.C. §103. There is simply no apparent reason from the combination of references for a person skilled in the art to apply a dendritic polymer *and* a water-insoluble phosphate to the surfaces of a hydrogel-forming polymer particle.

Claim 2 stands rejected under 35 U.S.C. §103 as being obvious over the '646 patent in view of the '429 patent as evidenced by the '218 patent in view of the '469 patent and further in view of Sorensen et al. U.S. Patent No. 6,093,777 ('777). Applicants traverse this rejection.

The rejection of the claims over a combination of the '646, '429, '218, and '469 patents has been discussed above. The '777 patent fails to overcome the deficiencies of this combination of references.

The quaternary '777 patent teaches a dendritic polymer used in a thermosetting resin matrix to provide a toughening effect. First, the '777 patent is completely silent with respect to incorporating the dendritic polymer onto an SAP. SAPs are not thermosetting resins. Second, the present claims are directed to SAP particles that absorb several times their weight of aqueous media and swell. Therefore, a "toughening affect" is irrelevant with respect to particles, and is to be avoided because swelling of the particles in aqueous media may be impaired.

Therefore, it is submitted that claim 2 is patentable under 35 U.S.C. §103 for all the reasons set forth above, and that the rejection of claim 2 over the combination of cited references should be withdrawn.

Claims 10, 11, 14, and 15 stand rejected under 35 U.S.C. §103 as being obvious over the '646 patent in view of the '429 patent as evidenced by the '218 patent in view of the '469 patent and further in view of Heide et al. U.S. Patent Publication No. 2004/0014901 ('901 publication). Applicants traverse this rejection.

These claims recite preferred embodiments of the present invention. Applicants do not rely solely on the features recited in claims 10, 11, 14, or 15 for patentability, but rely upon all the features recited in these claims *and* in independent claim 1. Applicants have demonstrated the patentability of claim 1 above, and the disclosure of the quaternary '901 publication does not negate the patentability of independent claim 1. Therefore, it is submitted that claims 10, 11, 14, or 15 are patentable for the same reasons claim 1 is patentable, and that the rejection of these claims under 35 U.S.C. §103 should be withdrawn.

It is submitted that all claims are in a form and scope for allowance. An early and favorable action on the merits is respectfully requested.

Should the examiner wish to discuss the foregoing, or any matter of form in an effort to advance this application toward allowance, the examiner is urged to telephone the undersigned at the indicated number.

Dated: July 1, 2009

Respectfully submitted,

By _____

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Exhibit B

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What found the top quark.
Archaeology in peril.
The Niels Bohr mysteries.

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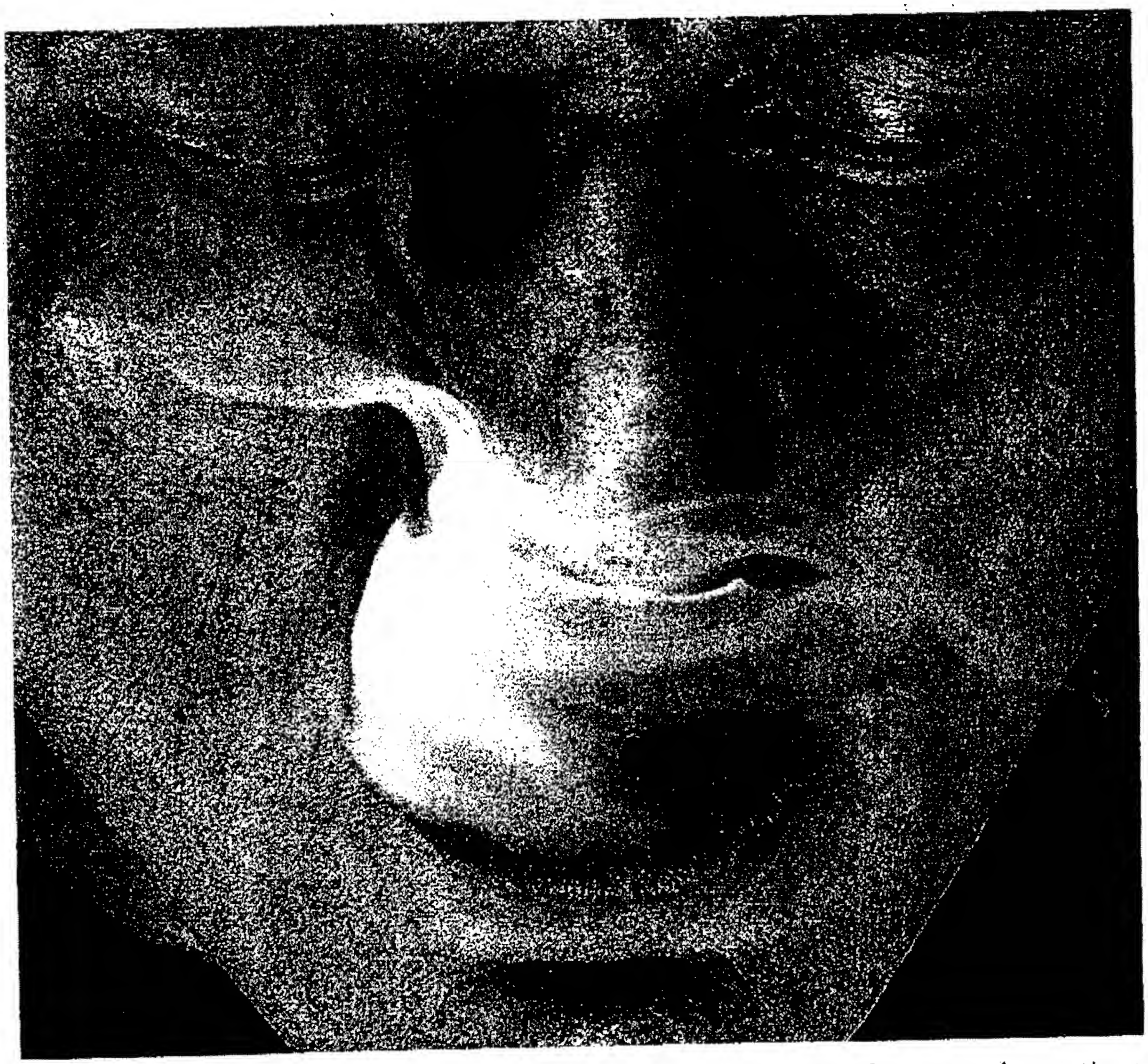

Clouds of tobacco smoke continue their spread, despite warnings.

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Dendrimer Molecules

Chemists can now build fractal supermolecules. This new class of polymers promises to be valuable in biotechnology and environmental protection

by Donald A. Tomalia

In the center of Michigan, along the Chippewa River, some 130 miles southeast of Sleeping Bear Dunes National Lakeshore, the land is not productive enough for traditional agriculture, but it is adequate for growing trees. Thousands of trees of all types, with every branching pattern and shape imaginable, flourish there. Year after year young seedlings with single trunks emerge. Then their trunks elaborate branches, and those branches produce more branches in the same way, giving rise to the lush and varied forest.

As I pondered these trees near my home some 20 years ago with the eyes of a chemist, the systems of branches made me wonder whether one could design large, precisely defined molecules by adding branch after branch onto some original substance. The idea of gaining such control over the formation of a molecule appealed to me immediately on both theoretical and practical grounds, but it was not until the end of the 1970s that I found a way to put the concept into practice. Today my technique and other similar approaches are making it possible to construct treelike molecules that mimic a variety of biological structures, including proteins. There is good reason to believe that these synthetic constructions will prove valuable in medicine, the electronics industry and other fields.

DONALD A. TOMALIA is a research professor and director of nanoscopic chemistry and architecture at the Michigan Molecular Institute in Midland. He received his bachelor's degree in chemistry from the University of Michigan, Flint College. In 1968, while working as a synthetic polymer chemist in Dow Chemical Company Research Laboratories in Midland, Tomalia completed his Ph.D. in chemistry at Michigan State University. He is a cofounder, director and the chief scientist of Dendritech, Inc. His major areas of interest are in structure-controlled polymers, molecular recognition and nanoscopic chemistry.

Long ago nature devised exquisite strategies for manipulating the structures of the molecules necessary for initiating and sustaining life. Chemists have tried for years to achieve such mastery over the structures they create. Organic chemists have gained substantial command over the synthesis of small complex molecules. But the goal of constructing large well-defined molecules has been more elusive.

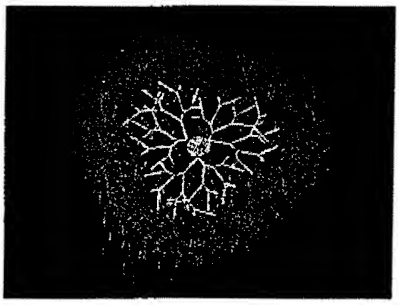
The idea of directing molecular growth to make these extremely large molecules with useful properties derived from experiments done in the 1930s, when Hermann Staudinger, then at the University of Freiburg, managed to link identical subunits, or monomers, into strings of spaghettilike molecules called random-coil polymers. Staudinger's work represented the first successful attempt at assembling large molecules from well-defined smaller components. But the investigator had little control over the lengths of the polymers, which spanned the continuum from microscopic (on the nanometer scale) to macroscopic (on the millimeter or centimeter scale). These polymers turned out to have interesting and valuable features; indeed, many familiar items are made of these types of random-coil polymers, including Styrofoam insulation, polyethylene milk cartons and Plexiglas.

About 10 years later Paul J. Flory, then at Cornell University, and Walter H. Stockmayer, then at the Massachusetts Institute of Technology, took another step toward making large molecules. They developed a second class of polymer that is formed by bridging, or cross-linking, random-coil polymers at various sites on the long chains. The loops and connections give rise to inflexible three-dimensional structures referred to as cross-linked polymers. Their rigidity makes these substances insoluble in most liquids and therefore useful as coating materials on fiberglass hulls of boats or in urethane foams and epoxy systems.

In both random-coil and cross-linked polymers, monomers are joined into long, meandering chains of molecules having varying lengths and sizes, and the precise internal arrangements are impossible for chemists to predetermine. My idea in the mid-1970s was to gain such control. I finally figured out how to achieve that objective after making a surprising discovery in 1979.

Just Add Methanol and Stir

One spring day colleagues in my laboratory and I were following our standard procedure for making linear random-coil polymers called polyamidoamines. Although typically the synthesis did not require a solvent, on this particular day we added one—methanol (CH_3OH)—to the initial set of ingredients in order to facilitate stirring. We did not expect methanol to alter the substances in this reaction chemically.



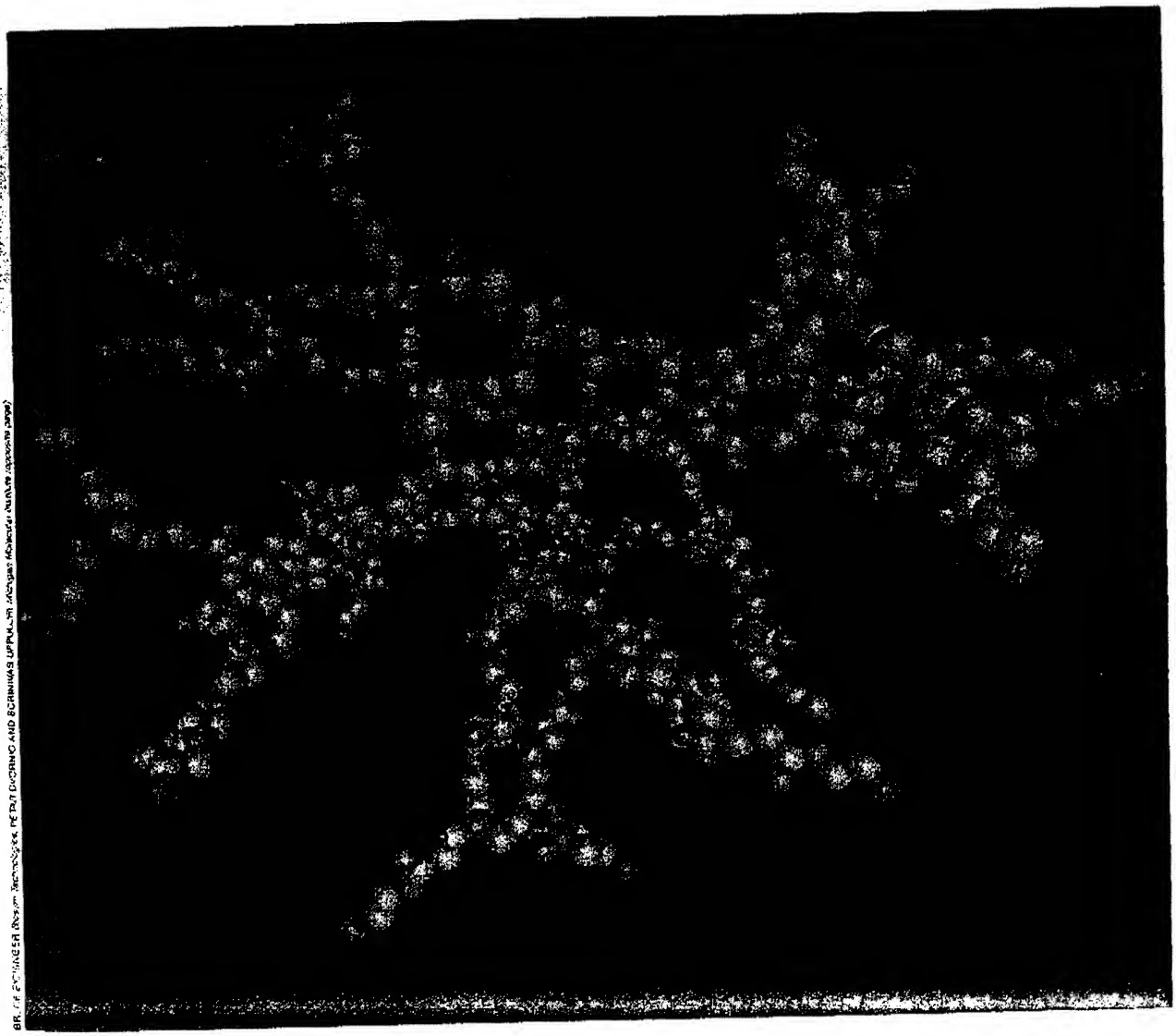
STARBURST DENDRIMERS, shown at the right and in cross section above, have an ammonia molecule at their core. These dendrimers consist of three branched "trees," parts of which are highlighted in the cross section. The trees were systematically built onto the core through an iterative process developed by the author and his colleagues.

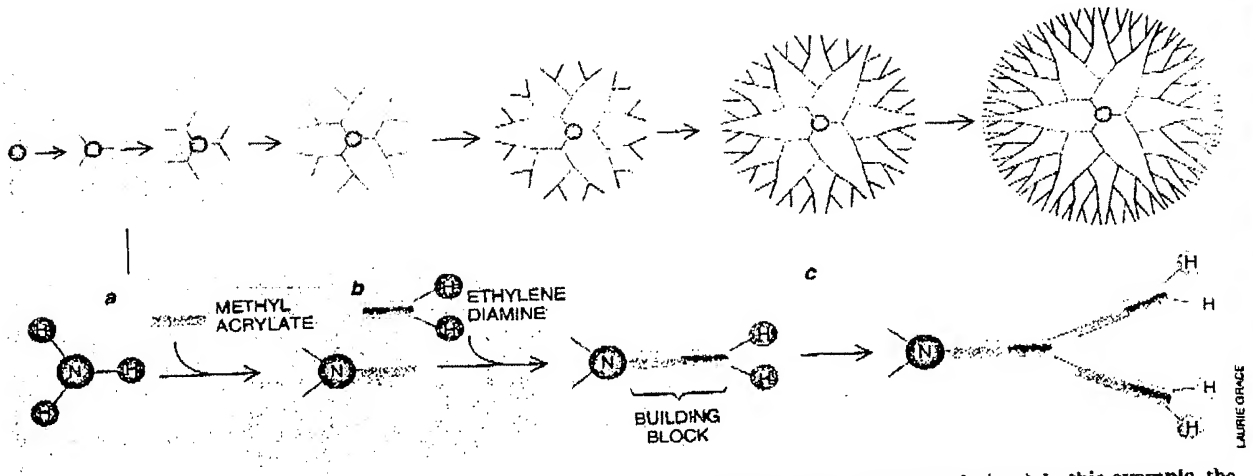
The rest of the process went along as usual: we mixed the monomer methyl acrylate ($C_4H_6O_2$) with ethylene diamine ($C_2H_8N_2$).

Much to everyone's amazement, we did not get the same random-coil polymer we usually made. Normally, when we mixed these two chemicals, they linked together in a one-to-one ratio, which resulted in a long continuous strand consisting of alternating methyl acrylate and ethylene diamine components. Instead, when we determined the structure of the product from this reaction, we discovered a remarkable arrangement: there were no long strands, only discrete units consisting of two methyl acrylate groups connected to each end of ethylene diamine. In this case the methanol did affect the reaction. It apparently facilitated the removal of hydrogen atoms from the nitrogens in ethylene diamine and enabled methyl acrylate to take their places.

When we repeated the process—now adding ethylene diamine and methyl acrylate to the existing simple structures—we generated an even more intricate compound. This structure contained 12 methyl acrylate and five ethylene diamine monomers. I soon realized we might be able to adapt this technique to assemble the branching molecules I had envisioned back in the woods of Michigan. These molecules would be quite different from the long chains of monomers found in classical random-coil and cross-linked polymers.

Staring at the pattern of those trees, I had specifically imagined a system of molecular growth that resulted in large symmetrical structures built in stages, much as seasonal branching of young trees leads gradually to the development of a broad assembly of branches in older trees. Onto one reactive site of an initial core molecule, a second, linear molecule could be added, producing a stem. Two additional molecules, similar to the linear one, could be attached to the free end of the second molecule,





GROWTH OF DENDRIMER proceeds by exponential addition to a core molecule (*top*). In this example, the core molecule contains one nitrogen atom and three hydrogen atoms (*detail*). First, the hydrogen atoms are replaced by a molecule called methyl acrylate (*a*), as is shown for just one of the three atoms. A second molecule—ethylene diamine—is added as well (*b*). Together the monomers constitute the basic building blocks of the dendrimer. The unattached end of this unit has two nitrogen-hydrogen bonds, and so the two steps can be repeated to affix two more sections to the growing structure (*c*). Now the unattached end of the structure has four nitrogen-hydrogen bonds, allowing four units to be attached subsequently. Repetition of the process gives rise to the intricate final structure. (Blue coloring highlights the fractallike growth.) The well-defined architecture contrasts with the irregular structure of a random-coil polymer (*left*).

producing a Y-shaped structure. Reiteration of this pattern, adding at least two more of these molecules to the tips of each added Y, would quickly lead to an ordered system of monomers.

This basic approach has resulted in the creation of an entirely new class of polymer architecture, in which concentric tiers of monomers—resembling the layers of an onion—are assembled around a single molecule (the initiator core molecule) at the center. As the layers build outward from this core molecule, the fractal, or dendritic, nature of the growing structure emerges: large regions resemble the smaller Ys formed by triplets of monomers. At the same time, the internal structure takes on a starlike appearance. We thus call the final products "Starburst dendrimers."

Adjustable Properties

We created our first dendrimers by repeatedly performing two simple operations that we still use to this day. When assembling dendrimers, we generally start with an ammonia molecule, which consists of a central nitrogen atom linked to three hydrogen atoms. To this molecule we add enough methanol to facilitate substitution of methyl acrylate for all three hydrogen atoms of the ammonia molecule. Next we add the second monomer, ethylene diamine, which attaches to the free end of each of the three methyl acrylate components. Because ethylene diamine has an amine (NH_2) group at its unbound terminal, all three branches on the central ammonia group now end in a nitrogen atom from which two hydrogen atoms protrude. In other words, the three outermost tips resemble the ammonia molecule at the core, except that six instead of three hydrogen atoms are available to react with additional methyl acrylate monomers.

Just as we are able to replace all three hydrogen atoms in ammonia with three methyl acrylate monomers, we are able to replace the six hydrogens from the three amine groups with six monomer units. To be more precise, in this second iteration of the two-step process, we attach six methyl acrylate molecules to the expanding structure and link ethylene diamine to each of the monomers. These six ethylene diamine-linked monomer groups—forming what we call the second generation of the dendrimer—provide 12 hydrogen atoms to start the third generation. Each successive generation exponentially increases the number of hydrogen atoms available to react.

We soon found that this approach, known as amplification chemistry, can be repeated through as many as nine or 10 generations, until the structure runs out of room to hold additional monomers in perfect branches. The procedure can yield enormous macromolecules, some of which have masses over a million times that of hydrogen (which has an atomic mass of one) and diameters more than 300 times that of hydrogen. And the outermost surface can carry hundreds or even thousands of reactive molecules, known as functional groups. These groups might be derived from the same monomers used to build the dendrimer, or they might be different functional groups, depending on the requirements of the intended application.

Because dendrimers have very regular and predictable patterns of growth, chemists can manipulate the characteristics not only of the interior of the molecule but also of the outer surface. Hence, they can additionally regulate the way the molecule chemically reacts with other molecules. In short, we can specify the size, shape and reactivity of the dendrimers, which allows us to manipulate the properties of the macromolecules we make to an extent that was not possible before.

Indeed, the adjustable physical and chemical properties of dendrimers are their most striking features. Chemists gain this control by carefully selecting the reactants used for making dendrimers. For example, the overall size of a dendrimer is determined by the number of generations included, the length of the monomers used in each generation and the angles between the monomers—features that depend on the chemical makeup of these molecules.

The final structure can also be shaped by the choice of the initiator core mole-

cule. Although the first dendrimers were built from an ammonia core, we have since explored derivatives of ammonia as well as completely different families of compounds, including phosphorus-containing or silicone-containing molecules, benzene (C_6H_6) rings and carbon chains (which have hydrogen and sometimes oxygen atoms attached to them). Each different combination of core molecule and monomers results in a unique dendrimer structure with distinct properties. For instance, if we start with a molecule derived from ammonia but with only one available hydrogen atom, the dendrimer will resemble a mushroom cap. With two active hydrogens, the dendrimer looks more like a kidney-shaped molecule rather than the symmetrical spheroid that is obtained from a pure ammonia core.

As often happens in science, we were not the only researchers to discover a way to build branched molecules. Fritz Vögtle of the University of Bonn and his team were also investigating the possibility of constructing branched molecules around the same time. After we produced our first dendrimers, we learned that Vögtle's group had used a type of amplification chemistry similar to ours to synthesize small branched molecules. The other team's structures consisted mainly of derivatives of ammonia linked by the monomer acrylonitrile. The German researchers called their products "cascade molecules." Other German and Dutch investigators more recently showed that by using a different catalyst in the procedure, the Vögtle approach could be adapted for making large dendrimers as well.

Since 1979 many groups have used methods similar to ours and Vögtle's to synthesize these dendritic supermolecules. In 1985 George R. Newkome of the University of South Florida pioneered an alternative type of amplification chemistry to produce treelike molecules, which he referred to as arborols.

Another interesting approach to dendrimer synthesis was described in 1989 by Jean M. J. Fréchet and Craig J. Hawker of Cornell University and, separately, in 1990 by Timothy M. Miller and Thomas X. Neenan of AT&T Bell Laboratories. Instead of using the so-called divergent method—starting from the inside and building outward—as our laboratory does, these chemists used what is known as the convergent method of synthesis. They constructed individual branches first and then attached the units to a central core molecule.

Between 1980 and 1990 fewer than a dozen papers were published on this subject, but in the past several years there has been an explosion of activity. More than 20 types of dendrimer families with more than 100 different surfaces have now been reported. Apparently, a wide variety of monomers—including metals—may be used to create dendrimers. Moreover, it seems that virtually any functional group that can be found in an organic chemistry textbook can be attached to the surface of dendrimer molecules to carry out selected tasks.

Parallels in Nature

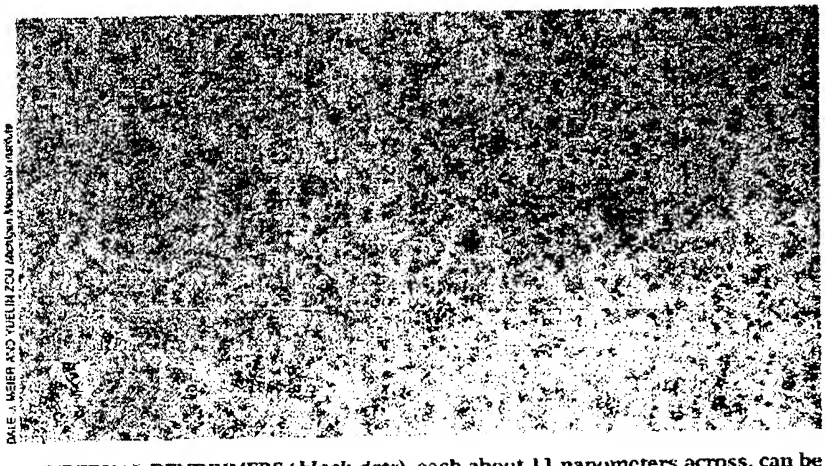
Chemistry is not just about connecting and rearranging atoms in various ways. It is a philosophy, a way of thinking about the dimensional hierarchy of the universe, from the simplest atoms to the most complex molecules and phenomena. The order in atoms and molecules is echoed everywhere in nature, from the branching schemes of trees and coral reefs to the dendritic networks of airways in the lungs and blood vessels in the circulatory system. The significance of these pervasive patterns is not entirely clear, but such connections are fascinating to contemplate.

For example, dendrimers have many intriguing organizational similarities to atoms. As dendrimers or atoms form, curious geometric or arithmetic patterns usually develop. These schemes may involve various repetitive structures or regular sequences of numbers. For example, the number of monomers in a dendrimer with an ammonia core increases in a well-defined sequence: 3, 6, 12, 24, 48 and so on. In this way, concentric dendrimer amplification resembles the accumulation of electrons in successive elements of the periodic table. The number of electrons within each orbital of an atom is also limited. The innermost electron cloud of an atom may not contain more than two electrons; the first generation in an ammonia-based dendrimer may not contain more than its saturation value of three monomers.

Additional parallels can be drawn between the branching network inside dendrimers and certain patterns of biological development. Dendritic growth in these molecules resembles the exponential growth seen during cell mitosis, the process in which one cell becomes two, two cells become four and so on. Furthermore, the original core of the dendrimer determines its final structure, just as the characteristics of the dividing cells derive their unique features from the genetic makeup of the original cell.

The similarities between dendrimers and atoms (the fundamental building blocks of nature) and the parallels between dendritic and biological development may well have practical implications. They suggest that individual or even larger assemblages of the structures might eventually be exploited as synthetic replicas of biological molecules. This notion is reinforced by the fact that dendrimers are about the same size as some of the most important molecules in nature, including enzymes, antibodies, DNA, RNA and viruses.

Scientists have frequently marveled at the way living systems outdo our most advanced techniques for manipulating and combining atoms into large biological molecules. Although dendrimers represent only one of several approaches to building molecules in this



DALE J. MEIER AND YUELIN ZOU (Michigan Molecular Institute)

INDIVIDUAL DENDRIMERS (*black dots*), each about 11 nanometers across, can be seen with an electron microscope. They are similar in size to many large biological molecules. Dendrimers can also be assembled into much bigger clusters.

size range, it seems clear that these structures will function as the basis for what I like to call a new, nanoscopic chemistry set for constructing complex molecules that mimic biological compounds in size, shape and function.

One of the many exciting indications that dendrimers can have practical uses has recently come from my laboratory and that of James R. Baker, Jr., of the University of Michigan Hospital and, separately, from the laboratory of Francis C. Szoka, Jr., of the University of California at San Francisco. We have found evidence that dendrimers might one day be valuable in gene therapy, as vehicles for bringing DNA sequences into cells.

Dendrimers Deliver DNA

The DNA-transporting structures we fashioned resemble clusters of proteins called histones. In the human body, nuclear DNA is found wrapped around such clusters. Our dendrimers are so close in shape and size to a histone cluster that DNA wraps around them just as it does around the natural protein complex. The DNA we studied contained a genetic sequence that codes for the protein luciferase, the substance that gives fireflies their luminescence. This gene is rather easy to track: when it is successfully transferred to a new cell and remains functional, the cell begins to glow.

In petri dish experiments, we combined histonelike dendrimers and the luciferase gene with close to 30 different types of cells from various species, including humans. In nearly all cases, the dendrimers transported genetic material into the cell and gave rise to the luciferase protein. (We do not yet completely understand how the dendrimer-DNA unit makes its way into cells.)

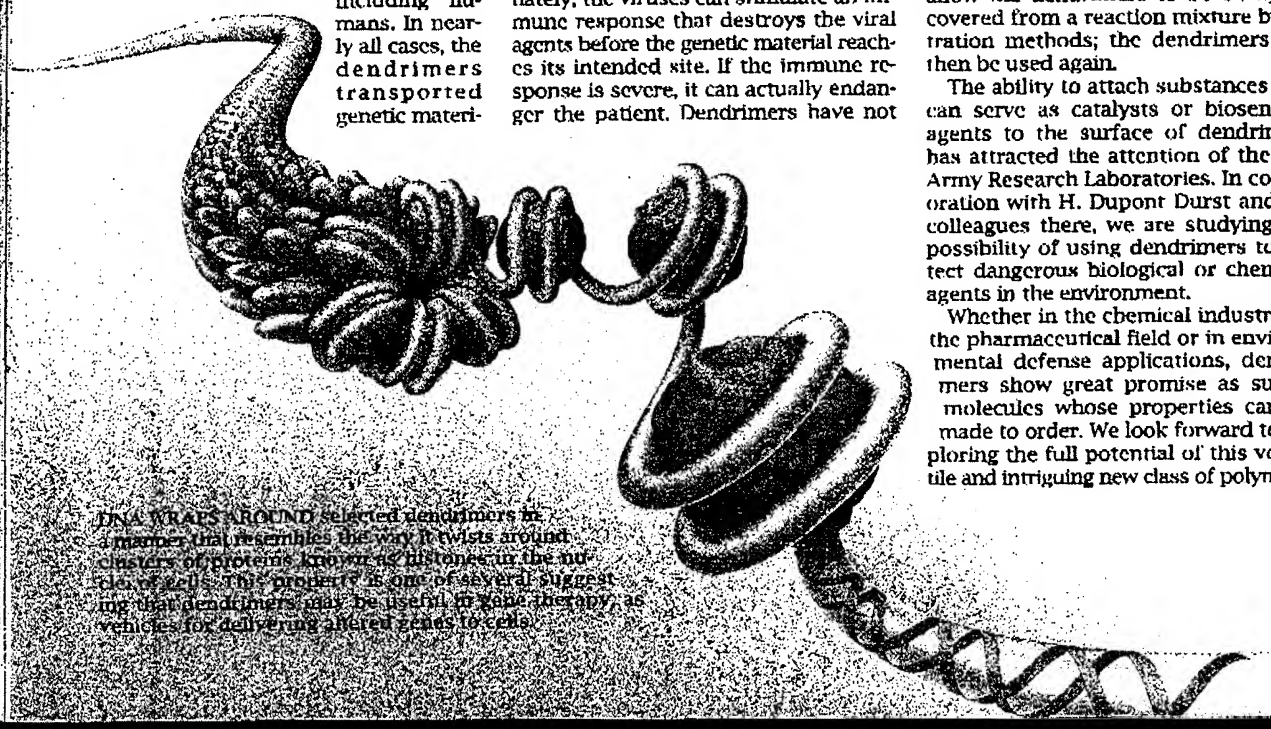
We have other reasons for suspecting that dendrimers might be of service in gene therapy. Notably, the structures can be designed to home in on specific target cells. For example, attaching certain substances, particularly sugar and protein groups, to dendrimer surfaces causes these polymers to adhere more favorably with some cell membranes than with others. By carefully selecting the components we add, we can direct a dendrimer-DNA combination to specific types of cells.

Furthermore, dendrimers may have an advantage over the current method of delivering genetic material to cells. Today scientists often use modified viruses to bring genes to cells. Unfortunately, the viruses can stimulate an immune response that destroys the viral agents before the genetic material reaches its intended site. If the immune response is severe, it can actually endanger the patient. Dendrimers have not triggered such an extreme response in any of our laboratory studies. Many research teams are also developing techniques for transporting other kinds of molecules, such as drugs, to selected targets in the body.

Last December, Gerard van Koten and his group at Utrecht University in the Netherlands identified another application for dendrimers that could have great significance for the chemical industry. In many manufacturing processes, chemical plants must use catalysts to enhance the efficiency of certain reactions. The outside of a dendrimer can be covered with many catalytic sites, so that one dendrimer can induce a large number of catalytic reactions. These dendrimers typically dissolve in the reaction mixture readily, which further facilitates catalysis. Additionally, the large size of the structures should allow the dendrimers to be easily recovered from a reaction mixture by filtration methods; the dendrimers can then be used again.

The ability to attach substances that can serve as catalysts or biosensory agents to the surface of dendrimers has attracted the attention of the U.S. Army Research Laboratories. In collaboration with H. Dupont Durst and his colleagues there, we are studying the possibility of using dendrimers to detect dangerous biological or chemical agents in the environment.

Whether in the chemical industry, in the pharmaceutical field or in environmental defense applications, dendrimers show great promise as supermolecules whose properties can be made to order. We look forward to exploring the full potential of this versatile and intriguing new class of polymers.



DNA WRAPS AROUND selected dendrimers in a manner that resembles the way it twists around clusters of proteins known as histones in the nuclei of cells. This property is one of several suggesting that dendrimers may be useful in gene therapy, as vehicles for delivering altered genes to cells.

TOMO NARASHIMA

FURTHER READING

STARBURST DENDRIMERS: MOLECULAR-LEVEL CONTROL OF SIZE, SHAPE, SURFACE CHEMISTRY, TOPOLOGY, AND FLEXIBILITY FROM ATOMS TO MACROSCOPIC MATTER. Donald A. Tomalia, Adel M. Naylor and William A. Goddard III in *Angewandte Chemie, International Edition in English*, Vol. 29, No. 2, pages 138–175; February 1990.

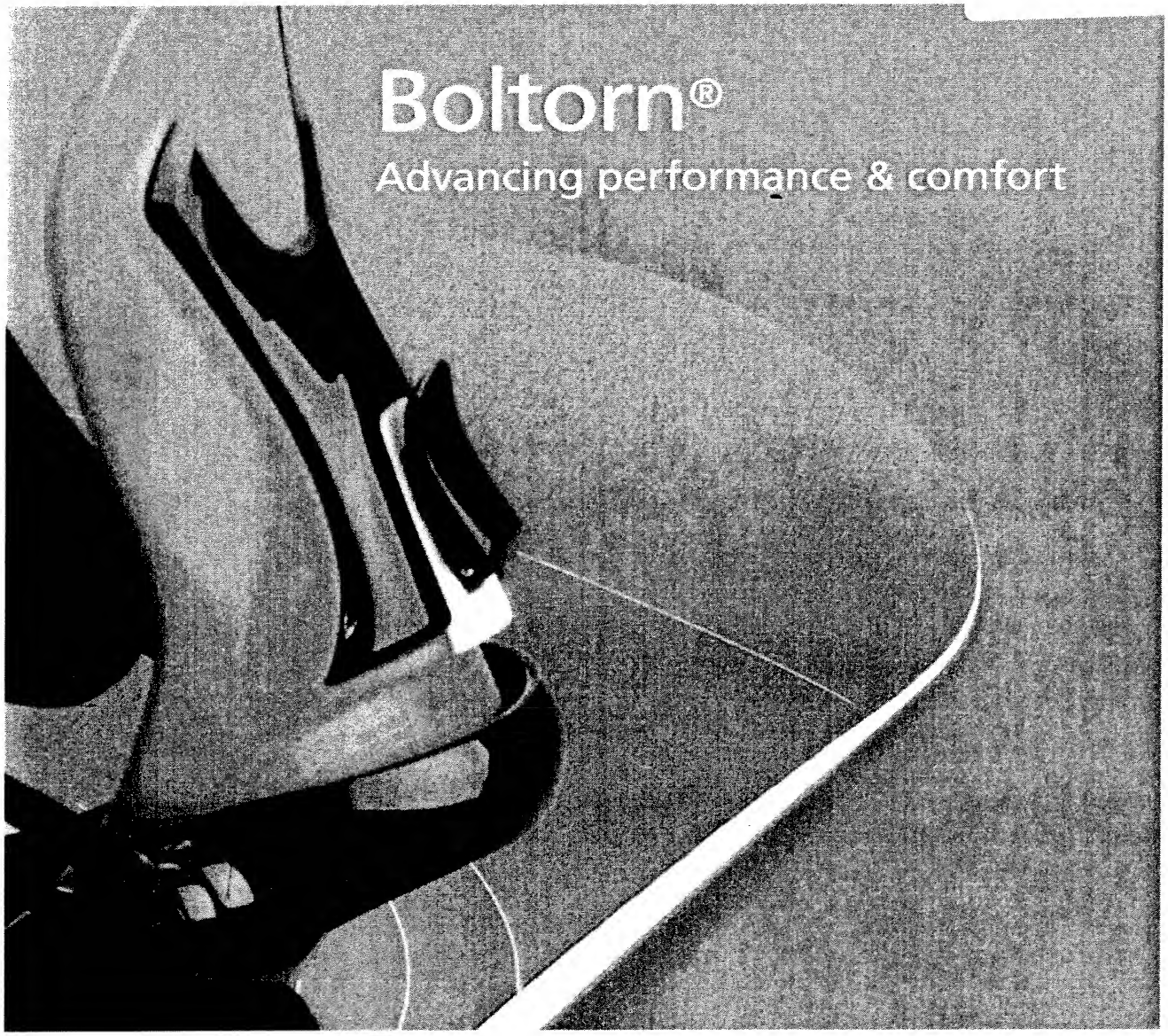
RISING CHEMICAL "STARS" COULD PLAY MANY ROLES. Joe Alper in *Science*, Vol. 251, pages 1562–1564; March 29, 1991.

DENDRIMERS, ARBOROLS, AND CASCADE MOLECULES: BREAKTHROUGH INTO GENERATIONS OF NEW MATERIALS. Hans-Bernhard Mekelburger, Wilfried Jaworek and Fritz Vögtle in *Angewandte Chemie, International Edition in English*, Vol. 31, No. 12, pages 1571–1576; December 1992.

FUNCTIONAL POLYMERS AND DENDRIMERS: REACTIVITY, MOLECULAR ARCHITECTURE, AND INTERFACTAL ENERGY. Jean M. J. Fréchet in *Science*, Vol. 263, pages 1710–1715; March 25, 1994.

STARBURST/CASCADE DENDRIMERS: FUNDAMENTAL BUILDING BLOCKS FOR A NEW NANOSCOPIC CHEMISTRY SET. D. A. Tomalia in *Advanced Materials*, Vol. 6, Nos. 7–8, pages 529–539; July–August 1994.

Exhibit C



Our dendritic polymers

- Secure exceptional firmness and comfort in flexible polyurethane foam
- Improve the Tg/flexibility ratio of cast polyurethane elastomer products
- Ensure rapid curing, excellent durability and low toxicity in UV curing applications
- Provide reduced VOC and improved performance in architectural coatings

Perstorp
WINNING FORMULAS

The elements of success

You need a partner who can see the big picture when it comes to your products, your processes and your customers. Our experience and expertise in the special niches of organic chemistry, process technology and application development are at your service, providing you with a complete chain of solutions to enhance quality and profitability at every step.

Our versatile intermediates, an essential element of your winning formula, are specifically designed to add value and enhance end-product performance. Your solution to meeting the increasing demands for safer, lighter, more durable and environmentally friendly end-user products, begins here.

Innovation in everything we do

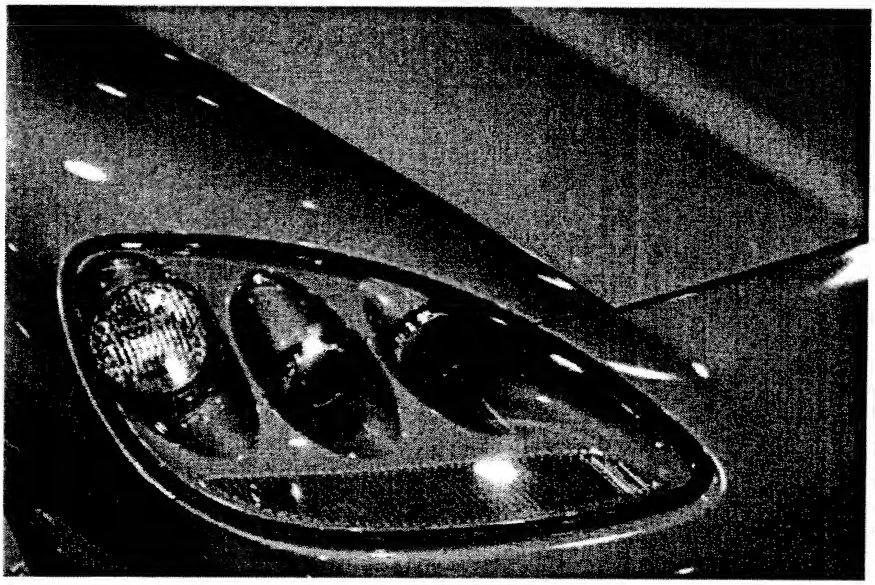
Innovation distinguishes every aspect of our business process. Developing smarter and safer solutions creates real value in new chemical applications. Focused innovation instills leadership and purpose in our business activities, improves internal processes and increases application and product competitiveness.

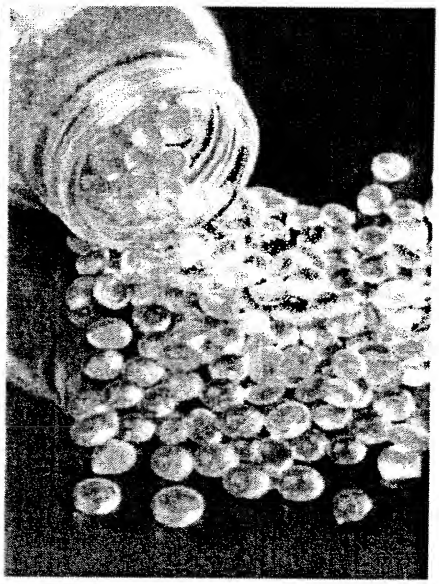
Delivering our promises globally

Our global presence provides you with reliable solutions and processes, consistent high quality, security of production and supply and delivery with precision. This commitment also means rapid response when product or application support is required and the very best in technical support.

Putting the care into chemicals

We take our responsibilities to heart and are committed to attentive, sustainable business practices. We minimize risks for our customers, our employees and the environment by working proactively to ensure safe products and processes.





Advancing performance & comfort

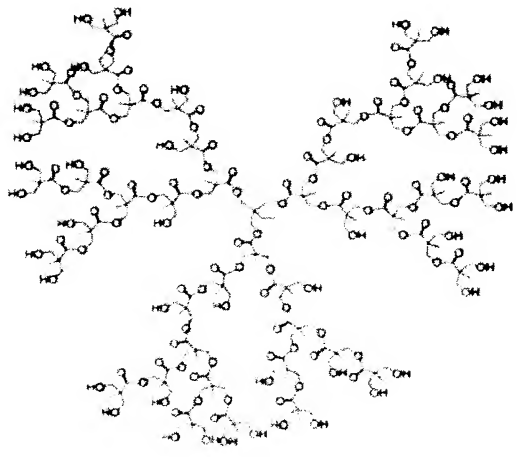
Sharpen your competitive edge by partnering with the global leader in bringing cost-effective dendritic polymers to the market. Dendritic polymers are characterized by a densely branched backbone and a large number of reactive groups. Their globular structures have excellent flow and processing properties at high molecular weight. The exceptional concentration of reactive groups facilitates customization of properties for a wide range of end uses.

The main applications of Boltorn® dendritic polymers:

- Performance additives for flexible polyurethane foam such as in automotive seating applications.
- Elastomer cross-linkers to improve the Tg/flexibility ratio of cast polyurethane elastomer products.
- Oligomer precursors for UV curing applications to achieve very rapid curing and excellent properties.
- Performance resins for architectural coatings to convert solvent borne resins to waterborne equivalents and reduce the VOC of solvent borne paints.

Boltorn® technology

- Large number of primary hydroxyl groups
- Densely branched polymer backbone
- Extensive formulation possibilities



The cutting edge of technology

Our Boltorn® products are produced using polyalcohol cores, hydroxy acids and technology based on captive materials. The dendritic structures are formed by polymerization of the particular core and 2,2-dimethylol propionic acid (Bis-MPA). The base products obtained are hydroxyl-functional dendritic polyesters. Fully aliphatic and consisting only of tertiary ester bonds, they provide excellent thermal and chemical resistance. Extensive branching also improves reactivity, lowers viscosity and results in balanced mechanical properties. Five base products are available as polymer building blocks and elastomer cross-linkers representing a range in molecular weight, hydroxyl functionality, glass transition temperature (Tg) and polarity.

Our dendritic base products:

Boltorn® H20
16 terminal hydroxyl groups,
nominal molecular weight of 1,750 g/mol

Boltorn® H2003
12 terminal hydroxyl groups,
nominal molecular weight of 2,300 g/mol

Boltorn® H2004
6 terminal hydroxyl groups,
nominal molecular weight of 3,100 g/mol

Boltorn® H30
32 terminal hydroxyl groups,
nominal molecular weight of 3,600 g/mol

Boltorn® H40
64 terminal hydroxyl groups,
nominal molecular weight of 7,300 g/mol

We welcome your questions. More detailed information and specifications of each product are available on www.perstorp.com or through your Perstorp sales representative.

Fine-tuning with polyols

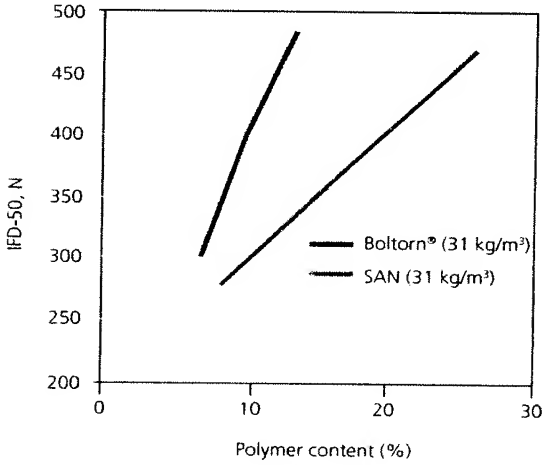
Boltorn® for polyurethanes

Millions of car owners already enjoy superior seating comfort with the help of Boltorn® technology. In partnership with a leading automotive foam supplier, we have developed a unique technology that improves the firmness of high-resilience foam articles with dendritic polymer polyols.

Boltorn® H311 – for exceptional firmness & stability

This liquid polymer polyol provides exceptional compressive load-building characteristics in flexible foam at very low addition levels. It is used as an additive, partially replacing conventional cross-linkers or graft co-polymer polyols of SAN-type. Compared to conventional technology, Boltorn® H311 offers considerable benefits:

- Two to three times the efficiency in providing compressive loads (IFD or CFD) at a given addition solids level, which allows lower average solids levels to be used.
- Exceptional firmness, extending beyond current state-of-the-art technology.
- Improved foam stability due to the cross-linking mechanism and reduced surface voids of finished parts.



Compressive load as function of polymer content for Boltorn® H311 vs. co-polymer polyols

Boltorn® P500 – new release for high firmness at low compression set

Our newly launched dendritic polymer polyol for molded foam is a liquid water-free product that yields exceptionally low compression set at high firmness when used with graft co-polymer polyols. The low compression set allows you to operate at reduced foam density and still meet the comfort specifications of end users.

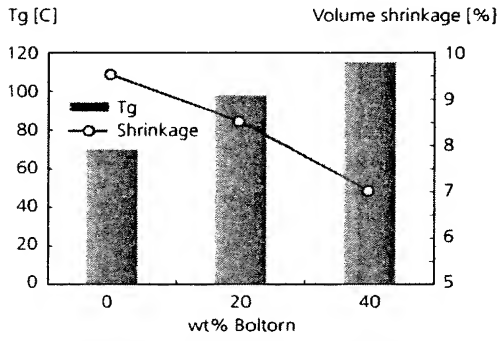
Formulation	60-5	60-15	50-11-4
Polyol (Hyperlite 1656), pph	87.95	63.85	63.51
Co-polymer polyol (Hyperlite 1650), pph	12.05	36.15	36.49
Boltorn® P500, pph	0	0	4.19
DEOA-LF, pph	0.50	0.50	1.00
Glycerine, pph	0	0	0
H_2O, pph	1.76	1.75	2.21
DABCO 33-LV, pph	0.10	0.10	0.36
NIAX A-1, pph	0.08	0.08	0.08
PC77, pph	0.20	0.20	0.00
Y10184, pph	1.00	1.00	0.70
TDI 80, pph	23.61	23.12	33.72
Total wet weight, g	127.25	126.75	142.26
Total dry weight, g	119.60	119.10	130.75
SAN, %	5	15	11
Boltorn® P500, %	0	0	4
Density, kg/m³	60	60	50
IFD-25, N	147	239	192
IFD-65, N	390	633	558
Dry set, %	4	4	2.9

Density reduction at reduced compression set when using Boltorn® P500

Boltorn® for radiation curing

Cross-linkers for increased durability

We offer you two dendritic polyester polyols suitable as cross-linkers for cast polyurethanes and elastomers. Boltorn® H2003 is a polyol of relatively high molecular weight and high hydroxyl value. Added to a polyurethane formulation, it improves the Tg and Shore-hardness of some formulations with aliphatic isocyanates. Boltorn® H2004 is a liquid product with hydrophobic chain stoppers that is used to yield durable systems with high flexibility.



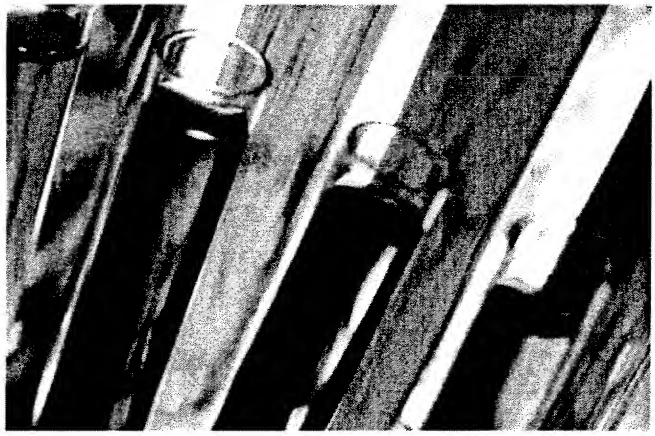
High molecular weight and functionality of acrylated Boltorn® oligomers improves hardness and Tg, yet reduces shrinkage and curl, when replacing polyether in polyether/PEOTA formulation

Oligomer precursors for superior performance

Boltorn® products enhance radiation curing applications by providing oligomer precursors that significantly increase the average molecular weight of UV formulations at high acrylate concentration. Acrylates based on Boltorn® technology are typically used to partially or fully replace urethane acrylates, other top-end oligomers or acrylates of high functionality. Using Boltorn® dendritic polyols as starters for oligomer acrylates offers significant benefits:

- Excellent reactivity
- Improved scratch resistance and film hardness
- Low shrinkage and good adhesion
- Exceptional flow properties and good pigment wetting
- Improved labeling with low extractables
- Unique molecular weight/viscosity ratio

For coatings, the balance between flow and properties like reactivity, and chemical and scratch resistance, is crucial for meeting end-user demands. Environmental compliance is also a key competitive factor. Radiation curing systems, typically UV, have gained market share in the past decades as very rapid curing and excellent film properties are obtained with low or no VOC emissions.



Acrylated polyol	Di-Penta (DPHA)	Acrylate of Boltorn® P500
Viscosity, mPas, 100% solids, 23°C	14,000	700
Min. UV-dose, tack-free, mJ/cm²	200	200
Erichsen-flex., aluminum, mm	0.4	2.2
Pencil hardness, PC- Sheet, 250µm	3H/4H	2H/3H
Scratch resistance (200 rubs), gloss 60° ret., %	90	91
Tape adhesion on PC-sheet, 0-5, 5 best	2	5
Adhesion, 180° bending test	No	OK

Properties of acrylated Di-Penta and acrylated Boltorn® P500 – all coating formulations cured with 3% Irgacure 500 from Ciba at 12µm film thickness with a UV-dose of 500 mJ/cm² unless otherwise stated

Designed to enhance

Boltorn® for architectural coatings

Boltorn® resins – safer performance

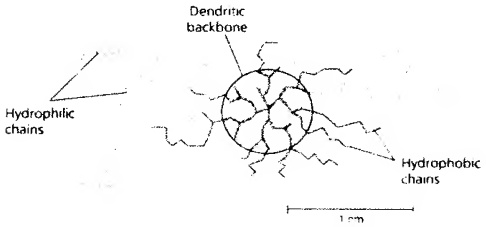
Our Boltorn® performance resins for solvent borne and waterborne architectural coatings help coating formulators comply with environmental demands without compromising coating performance. A number of patented technologies have been developed in which Boltorn® resins improve the performance of architectural coatings. Achieve excellent properties including reduced VOC, improved drying of woodstains and conversion of conventional solvent borne resins to waterborne equivalents.

Boltorn® U3000 – unique flow properties

For high-solid alkyds, the branched structure of Boltorn® U3000 provides unique flow properties, which allows woodstains and alkyd paints for outdoor applications to comply with recent VOC demands while still securing rapid drying and durability.

Boltorn® W3000 – efficient & powerful by design

The unique structure of dendritic polymers offers extensive design possibilities. We have developed Boltorn® W3000, a dispersing resin for converting conventional solvent borne alkyd paints into waterborne equivalents. The amphiphilic dendritic structure of Boltorn® W3000 contains both non-ionic water-dispersible and hydrophobic air-drying groups. The result is a powerful high molecular weight surfactant, which also contributes to drying and film properties.



Schematic structure of Boltorn® W3000

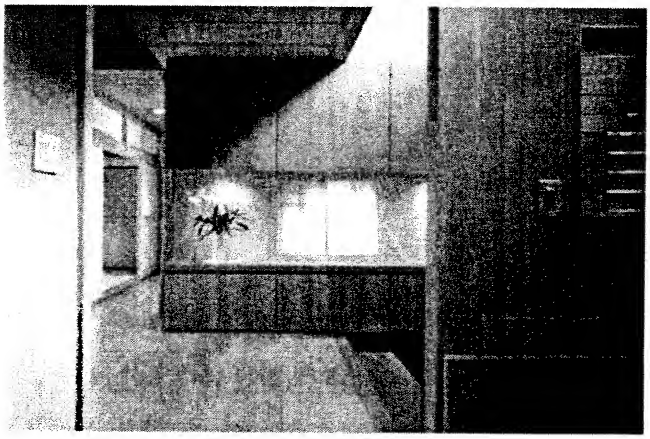
Formulation	Conventional woodstain	+40wt% Boltorn® U3000
Type	oil/alkyd	oil/alkyd/dendritic alkyd
VOC, g/l	595	238
Viscosity, 23°C, mPas	28	72
Drying properties (45µm dry film)		
Film hardness-1 day, Ks	5	45
Film hardness-10 days, Ks	27	35
Film hardness-17 days, Ks	27	33
Film hardness-31 days, Ks	26	33

Effect on VOC and drying properties when adding Boltorn® U3000 to a conventional woodstain available in Scandinavia

High-gloss paint for brush application	Boltorn® W3000 stabilized OL 65 alkyd emulsion	Solvent borne OL 65 alkyd (ref.)	Conventional OL 65 alkyd emulsion
Boltorn® W3000, wt% in paint	2.3	-	-
Alkyd (OL65), wt% in paint	21.4	34.4	-
Alkyd OL65-internally emulsified	-	-	31.8
Solids content, wt%	49	67	51
PVC	17	17	13
VOC, g/l	0	270	0
Gloss, 60°	93	92	95
Drying*			
Dust-dry, h	0.5	0.5	0.5
Tack-free, h	4	3	1.5
Through dry, h	5	3.5	15.5
Hard, h	14	5	> 24

* Beck-Koller, glass panels at 23°C, 50% humidity, 25 µm DFT

The physical properties of a waterborne paint containing Boltorn® W3000 compared to a solvent borne counterpart and a conventional alkyd emulsion paint



Product data summary

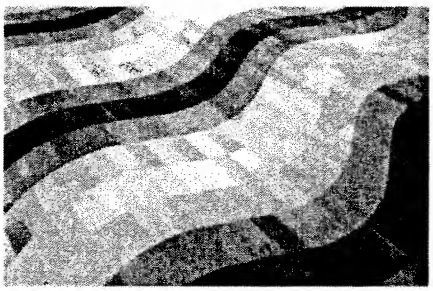
Product	Soluble in	Appearance	Functionality	OH-value mg KOH/g	Mw (GPC) g/mol	Tg (DMA) °C	Viscosity Pas (°C)
Polymer building blocks & CASE polyols							
Boltorn® H20	NMP, Diglym Acetone, Glycols	Opaque pellets	16	490 – 520	2,100	25	6 (110)
Boltorn® H2003	EtOH, MEK, Toluen	Transparent	12	280 – 310	2,500	-5	1 (110)
Boltorn® H2004	EtOH, Toluene, Xylene	Yellow liquid	6.4	110 – 130	3,200	-35	15 (23)
Boltorn® H30	MeOH, Acetone, NMP	Opaque pellets	32	490 – 510	3,500	35	40 (110)
Boltorn® H40	MeOH, Acetone, MEK	Transparent pellets	64	470 – 500	5,100	40	80 (110)

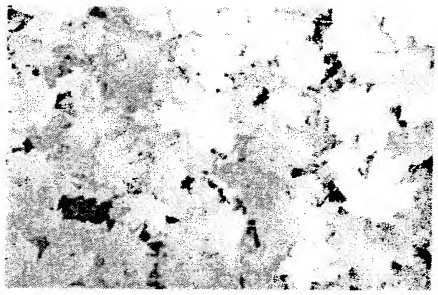
Product	Soluble in	Appearance	Water cont. wt.%	OH-value mg KOH/g	Mw (GPC) g/mol	Tg (DMA) °C	Viscosity Pas (°C)
Molded flexible foam							
Boltorn® H311	Polyether/ polyester polyols	Yellow liquid	9,5 – 10,5	235 – 255	5,500	-5	40 (23)
Boltorn® P500	Polyether polyols	Clear liquid	<0.5	560 – 630	1,800		12 (23)

Product	Soluble in	Appearance	Functionality	OH-value mg KOH/g	Mw (GPC) g/mol	Tg (DMA) °C	Viscosity Pas (°C)
Radiation curing							
Boltorn® H20	Acrylic acid + 15% toluene	Opaque pellets	16	490 – 520	2,100	25	6 (110)
Boltorn® H2003	EtOH, MEK, Toluen	Transparent	12	280 – 310	2,500	-5	1 (110)
Boltorn® P500	Acrylic acid + toluene	Clear liquid	hydroxyl	560 – 630	1,800	–	12 (23)
Boltorn® P1000	Acrylic acid + toluene	Clear liquid	hydroxyl	430 – 490	1,500	–	5 (23)

Product	Soluble in	Appearance	Functionality	Oil length % triglyc.	Mw (GPC) g/mol	Solids, %	Viscosity Pas (°C)
Architectural, waterborne coatings							
Boltorn® U3000	Oils, coalescents, EtOH, Xylene	Yellow liquid	Air-drying	77	6,500	99	1 (23)
Boltorn® W3000	Emulsifying, soluble in alkyds, co-solvents, xylene	Yellow wax	Amphiphilic Air-drying	45 (fully aliphatic)	10,000	99	2.5 (35)

Precisely tailored end-product properties





Your Winning Formula

The Perstorp Group is the world leader in several sectors of the specialty chemicals market. Few chemical companies in the world can rival its 125 years of success. Today we have a rich performance culture distilled from our long history and extensive knowledge in the chemical industry. That culture and knowledge base enables us to produce Winning Formulas for a wide variety of industries and applications.

Our products are used in the aerospace, marine, coatings, chemicals, plastics, engineering and construction industries. They can also be found in automotive, agricultural feed, food, packaging, textile, paper and electronics applications.

Our production plants are strategically located in Europe, North America and Asia and are supplemented by sales offices in all major markets. We can offer you a speedy regional support and a flexible attitude to suit your business needs.

If you want a chemical partner who can offer you focused innovation to enhance your product or application, which is delivered reliably and responsibly look no further. We have a winning formula waiting for you.

www.perstorp.com

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WINNING FORMULAS